PATENT SPECIFICATION

DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

Aircraft Lift-Increasing Device

I, EDWARD M. LANIER, of 900 Newportville Road, Croydon, Pennsylvania, United States of America, a citizen of the United States of America, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates generally to airfoils and more particularly to devices for increasing the lift of airfoils to provide a stable flight at low air speeds and/or more efficient flight at higher speeds. The invention relates specifically to improvements in the nature of the lift-increasing devices disclosed in applicant's prior United States patent 2,678,784, issued May 18th, 1954.

Achieving the design of an aircraft with short take-off and landing capability (STOL) as well as stable low-speed flight characteristics has long been a goal of industry and such characteristics are highly desirable in all types of aircraft now in use. The low speed handling characteristics of a particular aircraft are determined, in general, by the lift characteristics of the wings thereof. These lift characteristics, in turn, are generally a function of the "camber line" which as defined in B.S. 185 is "a line, each point of which is equidistant from the upper and lower boundaries of the aerofoil section, the distances being measured normal to the chord", that is, to the "straight line through the centres of curvature at the leading and trailing edges of an aerofoil section". As a general statement, and up to a certain degree, the greater the deviation of the camber line above the chord is an airfoil the greater the lift of that airfoil. To further generalize, however, the greater the deviation between the camber line and the chord, the greater the drag characteristics of the airfoil. It is common in the prior art to achieve low-drag, high-speed airfoils having high lift characteristics at low speeds, by providing a thin basic airfoil with a relatively flat camber and means to vary the camber in low speed landing and take-off situations. These means generally incorporate flaps on the trailing edge of the airfoil which, at low speeds are deflectable to a downwardly and rearwardly inclined position to effectively increase the curvature of the camber line thereby providing a high-lift configuration for low speeds.

Another way of increasing the lifting characteristics of an airfoil is to provide either span-wise slots through the wings or slats disposed along the leading edge of the wing, the slots being separable from the leading edge to define a slot therebetween. The openings produced by these devices are closeable to provide a low-drag configuration for high-speed operation and are openable to provide lift in a low-speed, high-angle of attack, situation. Lift is provided in the open condition, at low speeds since the openings channel the airflow from the high pressure undersurface of the airfoil through the wing and introduce it into the boundary layer of the low-pressure air flowing over the upper surface of the airfoil thereby increasing the energy in the boundary layer to delay separation thereof. Separation of the boundary layer gives rise to turbulence and thus reduces the lift and eventually results in stalling. Delaying the separation therefore lowers the stalling speed of the aircraft.

In the above-mentioned U.S. patent 2,678,784, an improvement over the prior art devices has been provided the improvement generally consisting of an openable channel or slot through the airfoil in combination with a lowerable scoop forming the lower portion of the channel disposed beneath. The lowerable scoop increases the flow of air through the channel into the boundary layer of the flow on the upper portion of the wing thereby improving the effectiveness

of the channel in increasing low-speed lift of the wing over prior art devices for landing and take-off and at maximum glide slope angles. The invention of this prior patent also serves to increase the effective curvature of the camber line of the airfoil somewhat to thereby further increase lift at low speeds.

In accordance with the present invention there is provided an airfoil for an aircraft having an openable and closeable passage through the airfoil extending over at least part of the span of the airfoil, the passage sloping upwardly and rearwardly from an inlet at the lower surface of the airfoil to an outlet at the upper surface and converging from the inlet to accelerate the flow through the passage and the passage being defined between a fixed front wall and a movable rear wall having a lower portion which when the passage is open forms a scoop projecting below the lower surface of the airfoil, the rear wall being movable into a position in which its lower portion closes the inlet of the passage while the upper part of the passage is closed by engagement of the rear wall with the front wall, in which a span wise flap is pivotally connected to the lower portion of the movable rear wall and is movable from a retractable position substantially flush with the lower surface of the airfoil to an extended position inclined downwardly from the said lower surface below the scoop when the passage is open.

Preferably the flap is pivotally connected to the free edge of the lower portion of the rear wall.

The scoop and convergent passage operate in the manner described in U.S. Patent 2,678,784 to control the boundary layer flow over the airfoil and thereby provide increased lift for take off and landing. The addition of the flap helps to increase the flow through the passage to improve the boundary layer control and also deflects a portion of the air flow beneath the airfoil downwards to increase the effective camber of the airfoil.

The convergent passage tapering from its inlet to its outlet serves to accelerate the air flow therethrough in the same manner as in a Venturi channel. The effective camber of the airfoil is increased by the increased effective or apparent thickness of the airfoil caused by the presenece of the scoop and flap. The angle of the flap is variable either independently or in combination with the movement of the scoop to increase or vary the airflow into the inlet of the passage, the increased airflow being caused in part by the increased pressure head below the scoop generated by the depending flap. The device further increases the effective or apparent camber of the airfoil when the flap deflects the airflow below the scoop in a downward general direction.

The invention will now be described in more detail with the aid of examples illustrated in the accompanying drawings in which like numerals indicate like parts throughout and wherein:

Figure 1 is a sectional view of an airfoil in elevation showing a schematic diagram of lift-increasing devices and an actuating system therefor in accordance with the invention in a configuration for high-speed, low drag flight;

Figure 2 is a view similar to Figure 1 showing the lift-increasing devices in a configuration for producing high lift;

Figure 3 is a sectional view similar to Figure 1 of an airfoil incorporating another embodiment of the invention;

Figure 4 is a sectional view of a portion of an airfoil in elevation showing the airflow around one of the lift-increasing devices functioning in accordance with the invention;

Figure 5 is a plan view of an aircraft incorporating lift-increasing devices in accordance with the invention;

Figure 6 is a sectional view of an airfoil incorporating another embodiment of the lift-increasing device in accordance with this invention;

Figure 7 is a view similar to Figure 6 showing a lift-increasing device in accordance with the invention used with a lift-increasing and control device of the prior art;

Figure 8 illustrates a modification of the lift-increasing device of the invention in combination with movable end plates;

Figure 8A is a fragmentary end view of the device of Figure 8

Figure 9 is a view similar to Figure 8 showing a modified lift-increasing device of the type shown in Figure 3 in combination with fixed end plates;

Figure 9A is a fragmentary end view of the device of Figure 9; and

Figure 10 is a view similar to Figure 9 and showing a single modified lift-increasing device in accordance with the invention.

Referring now to Figure 1 of the drawings, a lift-increasing device and the actuating members therefor are disposed in an airfoil 16 shown in sectional elevation. A forward and a rearward closed passage are indicated generally at 17 and 18 respectively. The motive force for actuating the components of the device is transmitted to the airfoil through torque tubes 19 and 21 running span-wise through the wing and connected to control members (not shown) in the aircraft.

Actuation of these torque tubes is accomplished by movement of the control member which movement, through conventional linkages, results in rotation of the tube to effect actuation of the respective flight controlling components. The linkages, although described hereinafter as rods, could of course be cables, hydraulic circuitry or even electrically connected servomotors. The rods referred to

hereinbelow are the standard push-pull rods commonly used in aircraft control systems and are pivotally connected to the respective connecting parts. The torque tube 21 is connected through a forward rod 22 and rearward rod 23 to a forward compensating mechanism 24 and a rearward compensating mechanism 26 respectively. Connection of rod 23 to the compensating mechanism 26 is achieved through an input arm 27. A spoiler rod 28 is also connected to the input arm 27 to operatively connect a spoiler 29 thereto for actuation in response to movement of the torque tube 21. The forward rod 22 is similarly connected to the forward compensating mechanism through an input arm 31.

The torque tube 19 has, connected thereto, a forward push-pull rod 32 which in turn is connected at the other end thereof to a forward scoop bellcrank 33 pivotally mounted proximate the leading edge of the airfoil. A rearward rod 34 is also connected to the torque tube 19 and at the other end thereof, to a forward passage bellcrank 36. Extending rearwardly from the forward passage bellcrank 36, an interconnecting rod 37 connects a rear scoop bellcrank 38 thereto. An actuating rod 39 extends from the bellcrank 38 to a rear passage bellcrank 41 to provide interconnection therebetween.

Returning to the leading edge of the wing, the forward scoop bellcrank 33 has pivotally mounted thereto a forward scoop actuating rod 42 which is connected at its other end to a rear wall structure 43 of the front passage 17. The bellcrank 33 is also connected to a flap regulating rod 44 which is pivotally connected to a forward flap regulating arm 46 on the compensating mechanism 24. The compensating mechanism 24 has provided thereon a forward flap actuating arm 47 which is connected through a rod 48 to a forward flap bellcrank 49. A forward flap actuating rod 51 pivotally connects the bellcrank 49 to a forward flap 52.

The rear wall structure 43 is made up of a metal skin portion 53 which is sufficiently thin to be flexed to a certain degree. The skin 53 is backed up and supported over a major portion of its area by a series of curved stringers 54 each of which is pivotally connected to the wing structure at a pivot point 56. The skin 53 and the stringers 54 are not connected to one another proximate the pivot points 56 so that some separation therebetween exists in this area as shown in Figure 1. The stringers 54 are also pivotally connected to a series of stringers 57 at the other ends thereof to provide structural connection and support for the flap 52. Near the upper part of the forward passage, the bellcrank 36 is pivotally connected to the skin portion 53 proximate the point of separation from stringer 54 by a push-pull rod 58.

A rigid and somewhat complementary convex-concave skin 59 is disposed in contact with the skin portion 53 when the passage is closed and forms the rearward portion of the leading edge of the airfoil. As shown in Figure 1, the skin 59 abuts the skin portion 53 along the entire surfaces thereof especially at the inlet and outlet of the passage where they provide a smooth, unbroken airfoil configuration while the passage is closed. Although there is no mechanical connection between the leading edge and the remainder of the airfoil shown in Figures 1 and 2 at the point where the section illustrated is taken, structural connection is provided between these parts at suitable intervals along the span of the wing as will be described later.

Moving now to the trailing edge of the airfoil, a system is shown which is similar to that described for the forward edge.

A rod 61 connects the rear scoop bellcrank 38 to a rear wall structure 62 of the passage 18. The rear wall structure 62 is made up of a metal skin portion 63 and is backed up by curved stringers 64 in a manner identical to the structure described for the wall structure 43. Also, in a manner similar to the arrangement described for the forward passage 17, the stringers 64 are pivoted at a pivot point 66 proximate the top ends thereof. Connected to the rear scoop bellcrank 38 through a rear flap regulating rod 67, is a rearward flap regulating arm 68 on the rear compensating mechanism 26. The rear compensating mechanism also has provided thereon a rearward flap actuating arm 69 which is pivotally connected through a rod 71 to a rearward flap bellcrank 72. A rearward flap actuating rod 73 pivotally connects the bellcrank 72 to a rearward flap 74.

The operation of the devices thus far described is initiated through actuation of the torque tubes 18 and/or 21 by control members in the aircraft cockpit. If the aircraft is in normal flight and actuation of the spoiler 29 alone to provide normal control of the aircraft is desired, the torque tube 21 is rotated to actuate the rear push-pull rod 23 and the spoiler push-pull rod 28 to deflect the spoiler 29 and thereby apply control force to the airflow and to the aircraft in a conventional normal manner. The compensating mechanisms 24 and 26 are so designed that, when there is no deflection of the regulating arms 46 and 68 of the forward and rear compensating mechanisms respectively, there is no movement of the actuator arms 47 and 69, regardless of the amount of movement of the input arms 31 and 27. Deflection of the regulating arms 46 and 68 by actuation of the rear wall structures 43 and 62 will, depending on the amount of movement thereof, transmit a portion of the movement through the compensating mechanisms from the input arms 31 and 27 to the actu-

ator arms 47 and 69 until, when the rear walls and the regulating arms are fully deflected, the ratio between the movement of the input arms and the actuator arms reaches a maximum. In this manner, so long as the passages 17 and 18 are closed, the spoiler 29 may be actuated through the torque tube 21 without causing actuation of the remaining portion of the linkages heretofore described.

Referring now to Figure 2, the airfoil and the components thereof are shown in an actuated condition. The rear wall structures are shown actuated by rotation of the torque tube 19 which transmits movement to the wall structure 43 through the forward rod 32, forward scoop bellcrank 33 and forward scoop actuation rod 42 to move the lower portion of the rear wall structure downwardly into the airflow to form a scoop. Movement of the torque tube 19 also actuates the forward passage bellcrank 36 to open the upper part of the convergent passage formed by the skin 53 and the complementary forward skin 59. The movement of the upper part of the skin 53 is proportional to the amount of actuation of the scoop so that a passage of variable width is provided, the opening being dependent upon the amount of deflection of the scoop. The benefits of this proportionally variable passage will be described later.

Actuation of the rod 34 also moves the interconnecting rod 37 to actuate the rear scoop bellcrank 38, actuating rod 39 and bellcrank 41 as well as the rear scoop actuator rod 61 to open the rear passage by moving the upper part of the rear wall structure in an identical manner to that described for the forward passage. Actuation of the bellcranks 33 and 38 also, through movement of the forward flap regulating rod 44 and rear flap rod 67 depending upon the amount of actuation of these members provides a corresponding transmission of movement between the input arms 31 and 27 and the flap actuating arms 47 and 69 of the respective compensating mechanisms. This condition then causes, when the torque tube 21 is actuated, corresponding actuation of the forward and rear flaps 52 and 74 respectively through the corresponding push-pull rods and bellcranks.

The structure and mechanical linkages as described above thereby provide independent actuation of the spoiler 29 for normal flight control, independent actuation of the rear wall structures 43 and 62 to achieve maximum glide slope angles or simultaneous actuation of the rear wall structures, spoiler, and flaps 52 and 74 for increased lift capability particularly suitable for landing and take-off configurations. The spoiler 29 and the flap 74 combine to produce somewhat the same effect as a split flap in deflecting the airflow at the trailing edge of the wing. In addition the action of the flap 74, increases airflow through the passage 18 formed in the rear wing.

Insofar as the size of the passage openings and the ratio of inlet to outlet of the passage are concerned, these dimensions and ratios may be of whatever value gives optimum lift and efficiency to the wing. This optimum efficiency is, of course, a function of factors such as wing loading, plan-form wing shape, chord configuration, etc. It has been found with an airfoil in accordance with the invention tested in a wind tunnel that an inlet of 8 per cent of the chord length of the wing with an outlet of 2 per cent of the chord of the wing yielded optimum results for that particular configuration. The wind tunnel tests have also shown the desirability of increasing the size of the outlet of the passage when the scoop is lowered to give a large inlet. As compared to flight tests using a fixed outlet dimension of 1 per cent of the wing chord, low minimum flight speeds in the order of 19 miles per hour were achieved. The wind tunnel tests have shown that by increasing the exit size with the larger entrance size, increased lift co-efficients will be obtained and stable flight may be maintained at even lower air speeds. As described above, the structure of this invention requires the operation of the scoop in conjunction with a change of the air passage dimensions in proportion to the scoop operation to yield the above-described benefits. The increase in exit dimensions allows a greater volume of air to be passed through the passage with less spillage at the entrance thereof and therefore, provides for injection of greater quantities of air at higher velocities into the airflow over the upper portion of the wing to increase the flow circulation therearound and thereby provides lift at lower air speeds than heretofore possible. As the scoop is retracted into the wing, all of the dimensions decrease proportionally until the inlet and outlet of the passage are fully closed to provide a flush lower and upper airflow surface for low-drag high-speed flight as is shown in Figure 1 of the drawings.

Insofar as the chordwise disposition of the lift-increasing devices of this invention is concerned, it has been found that with a forward passage beginning with the inlet thereof at between 10 and 15 per cent of the chord on the lower surface of the wing and the outlet at between 30 and 35 percent of the chord length of the wing, and with the rear passage being disposed with the inlet in the neighbourhood of 60 to 65 per cent of the chord length of the wing and the outlet at between 75 and 80 per cent of the chord length of the wing, optimum effectiveness in increasing the lift in the wing can be achieved. Insofar as the lift-increasing effect of the above-described device is concerned, flight tests were made on the airplane using

a forward scoop and convergent passage on the outer panels of an aircraft wing with and without a conventional three-quarter span slotted flap. With the flaps along the airplane lost its lift between 41 and 44 miles per hour. With the flaps and the outer wing panels scoops in a full open condition, the aircraft could fly at approximately 19 miles per hour without loss of altitude. The major advantage provided by the scoop and flap system is the ability to create a high-volume, high-flow-rate air stream from the outlets of the passages while the aircraft is at a minimum aircraft flight speed, thereby increasing the lift in the wing and preventing separation of the boundary layer in a flight regime where a slot or a slat would have already lost its effectiveness. The provision of a variable drag capability offered by the forward and rearward scoops and flaps in addition to the high lift provided also affords an advantage for slow, steep descent landing maneuvers.

In Figure 3 of the drawings a further embodiment of the invention is shown. Parts in Figure 3 corresponding to similar parts in Figures 1 and 2 are indicated by like numerals increased by 200. In this embodiment a forward lift-increasing device shown generally at 217 comprising a scoop and a convergent passage is combined with a scoop and flap device shown generally at 218 of the type shown in Figures 1 and 2. A control crank 221, operated through cables from aircraft controls (not shown) actuates a forward spoiler 220 and an input arm 227 of a compensating mechanism 226 through forward and rearward push rods 222 and 223 respectively. A rear spoiler push rod 228 connects the input arm 227 to a rear spoiler 229. A torque tube 219, through a crank 233, actuates a forward scoop push rod 242, which is pivotally connected to a forward scoop 243 and a passage push rod 234. The push rod 234 is connected to a bellcrank 258, pivoted at 236, which in turn is connected to the skin of the rear wall of the passage as shown. An interconnecting push-pull rod 237 connects the bellcrank 258 to a rear scoop bellcrank 238 mounted proximate the rear passage. The remaining connecting links are similar to those described in Figures 1 and 2 and are indicated by the same numbers increased by 200. The operation of the apparatus of Figure 3 is essentially the same as that of Figures 1 and 2 with the exception that there is no forward flap deployed and, for the purposes of illustration, the variable outlet of the rear passage has been omitted. The configuration of Figure 3 will provide less lift-increasing effect than will that of Figures 1 and 2 and is included primarily to show the adaptability of the scoop and flap devices and the operating mechanisms therefore.

Turning now to Figure 4 of the drawings, a schematic view is shown of the trailing edge portion of an airfoil which has incorporated therein a scoop and flap mechanism in accordance with the invention. In this view, the scoop and flap are shown in an actuated condition and the resultant airflow through and around the device is illustrated by arrows. A high dynamic pressure area created by the device exists ahead of the scoop-flap juncture. The airflow over the wing is indicated by the solid arrows in this figure, while the airflow diverted through the passage by operation of the scoop and flap device is indicated by the broken arrows. The primary effect of the convergent passage is to accelerate the flow diverted by the scoop and flap so that the accelerated flow entering the air circulation above the wing increases that circulation thereby preventing low speed stall of the wing. Every convergent passage has an optimum ratio between the inlet and the outlet areas thereof whereby the acceleration of the flow therethrough is accomplished with the greatest efficiency. The maximum flow through the passage is furthermore governed by the width of the narrowest part or throat and once this maximum flow for a given throat is reached, the flow in excess of that will spill over the inlet and be wasted. By providing a variable passage, the ratio between the throat and inlet can be kept optimum thereby providing the most efficient acceleration of flow for any amount of deflection by the scoop and the flap and, the throat can be widened to accommodate increased flow into the passage provided by the increased flow diversion capability of the scoop and flap.

With reference to the flap effect of the scoop 62 and flap 74, the presence of the structure beneath the wing provides a simulated downward deflection of a portion of the chord of the wing at that point effectively making the ordinates of the camber line more positive in this region and, as a consequence, increases the lift at any given angle of attack. The success of a flap as a lift-increasing device is based on the fact that, although the stalling angle is reduced by the deflection of the conventional flap, the reduction is not great enough tol remove the gain arising for the shift of the lift curve as a whole. The invention as thus far described thereby provides the combination of the lift-increasing benefits achieved through a provision of a convergent passage through the wing to increase the boundary layer energy and total circulation over the airfoil and the provision of a scoop and flap depending beneath the wing to further increase the lift by the effect of changing the camber line of the wing.

Referring now to Figure 5 of the drawings an aircraft incorporating the devices of the invention in accordance with Figures 1 and 2 is shown. In this view the forward passage 17 is located proximate the leading edge of

the wing 16 and extends along the outboard portion of the wing. The rearward passage 18 extends substantially the entire open span of the wing. Chord-wise extending structural members 76 span the devices as necessary to maintain the structural integrity of the wing and thereby divides each device into span-wise segments. In the disposition of the structure as shown, the scoops are eliminated from the forward inboard section of the wing to allow the placement of fuel tanks in this area. The exact disposition of these devices will, of course, depend on such factors as the structural and storage requirements of the individual aircraft and it should be understood that the exact placement of the devices will be dictated by the specific requirements of the particular type of aircraft on which they are installed.

In Figure 6 a variation of this invention is shown with a forward lift-increasing device 378 in accordance with Figures 1 and 2 and a rearward lift-increasing device 377, comprising a modified scoop-flap structure in accordance with this invention, combined with a Fowler-type flap 381. The Fowler-type flap structure and the operation thereof is commonly known in the art. It basically consists of a flap which is lowerable and is provided with a rearwardly movable portion which extends in an essentially coplanar fashion on track structures to substantially increase the chord of the flap when in use. Two positions of this extensible flap are shown in solid and broken lines in Figure 6.

A further modification embodied in the lift-increasing device 377 consists of the addition of end plates 382 on each side of the scoop 362. These end plates may be disposed on each of the chord wise structural elements 76 (Figure 5) or may be disposed at any suitable interval along one or both sides of each of the openings between these structural elements as desired. They may also be supplied only on the rear lift-increasing device or the forward lift-increasing device as may be determined necessary by tests. These end plates prevent air spillage from the entrance to the passage to which they are next adjacent thereby increasing the flow through the passage with the resultant increase in lift produced thereby. The end plates may be fixed with respect to the scoop, as in this case, or fixed with respect to the wing surface, or retractable into the wing as will be shown later. Still a further modification of the basic invention shown in Figure 6 consists of an airfoil shaped divider 383 at the outlet of the passage, which creates a double channel outlet. This divider provides two high volume, high velocity outlets in place of one outlet and may be designed to be fixed in one position or may be equipped with apparatus (not shown) to pivot it on a spanwise axis so as to change the respective exit dimensions of the channels as well as the direction of the airflow. The divider 383 may also be used in conjunction with a spoiler or any of the other aforementioned standard control surfaces.

In Figure 7, an airfoil 416 is provided with a rearwardly disposed lift-increasing device 477 in combination with a spoiler 429 and a conventional flap 481. In modern high speed aircraft, roll control is generally accomplished by different control members depending upon the speed range in which the aircraft is operating. At high speed, such control is generally accomplished by killing a portion of the lift on one wing through the use of spoilers. The conventional control surfaces are used either alone or in combination with the spoilers at lower flight speeds since spoilers alone are less effective in this speed range. This combination thereby provides a combination control and lift-increasing device particularly adapted for use on high-speed aircraft.

Turning now to Figure 8, a rearward lift-increasing device 577 which comprises a scoop-flap 562 in accordance with the invention but modified with end plates 582 is combined with a forward lift-increasing device 578 which comprises a scoop structure 543 similar to the structure 217 in Figure 3 also modified with end plates 584. In Figure 8A a front view of the scoop 543 and end plate 584 of Figure 8 is shown. As can be seen in this view the end plate 584 is mounted on the transverse end of the scoop 543 and moves therewith so that the end plate retracts and extends with movement of the scoop itself.

Figures 9 and 9A illustrate a combination similar to that of Figures 8 and 8A wherein the end plates 678 and 682 are fixed to the lower surface of the airfoil 616. These end plates could be designed to remain permanently extended or could be provided with separate retracting mechanisms to provide retraction thereof separately from the scoops 643 and 662.

Figure 9 also shows in outline means for decreasing the air pressure on the upper surface of the airfoil which are described in detail in the aforementioned U.S. Specification No. 2,678,784, particularly in Figures 2 and 8 thereof. These means comprise a chamber 685 in the airfoil adjacent the passage jet exit, an inwardly swinging rigid door 686 hinged to the upper face of the airfoil and closing the jet exit and chamber 685 and means for variably moving said door into said chamber and exposing said jet exit to allow air to be projected over said door upon opening of the passage by the scoop structure 643.

The airfoil 716 of Figure 10 is provided with a rear lift-increasing device 777 which consists of a scoop 762 and flap 774 in accordance with the invention modified to

have an additional flap 781 mounted on the rear face of the flaps 774 on tracks so that it can be lowered rearwardly in the manner of a Fowler flap to increase the flap effect of the device.

WHAT I CLAIM IS: —

1. A airfoil for an aircraft having an openable and closable passage through an airfoil extending over at least part of the span of the airfoil, the passage sloping upwardly and rearwardly from an inlet to the lower surface of the airfoil to an outlet at the upper surface and converging from the inlet to accelerate the flow through the passage and the passage being defined between a fixed front wall and a movable rear wall having a lower portion which when the passage is open forms a scoop projecting below the lower surface of the airfoil, the rear wall being movable into a position in which its lower portion closes the inlet of the passage while the upper part of the passage is closed by engagement of the rear wall with the front wall, in which a span-wise flap is pivotally connected to the lower portion of the movable rear wall and is movable from a retracted position substantially flush with the lower surface of the airfoil to an extended position inclined downwardly from the said lower surface below the scoop when the passage is open.

2. An airfoil as claimed in claim 1 in which the flap is pivotally connected to the free edge of the lower portion of the rear wall.

3. An airfoil as claimed in claim 1 or 2 in which the movement of the rear wall is such that as the scoop is lowered to open the inlet to the passage the width of the passage is adjusted by separation of the rear wall from the front wall.

4. An airfoil as claimed in claim 3 in which an upper portion of the rear wall is flexibly deformable and is attached to an actuating mechanism which determines the width of the passage.

5. An airfoil as claimed in any of claims 1 to 4 in which the rear wall is formed by a flexibly deformable skin and rigid stringers swingably mounted at their upper ends and attached to the skin at their lower ends.

6. An airfoil as claimed in any of the preceding claims in which the front wall is of convex-concave configuration.

7. An airfoil as claimed in any of the preceding claims having an end plate which when the scoop is lowered is disposed beneath the lower surface of the airfoil at one end of the scoop, the end plate depending generally perpendicularly from the airfoil in a plane containing a chord of the airfoil.

8. An airfoil as claimed in any of the preceding claims having separate operating mechanisms for moving the rear wall and the flap, the operating mechanisms being linked so that no movement of the flap is possible while the passage is closed but progressively increasing movement of the flap can be effected as the passage is opened wider.

9. An airfoil as claimed in any of the preceding claims in which the flap in its extended position is inclined downwardly and rearwardly from the scoop.

10. An airfoil as claimed in claim 9 in which the passage and flap are located near the rear edge of the airfoil and a second passage defined in a like manner by a fixed front wall and a movable rear wall whose lower portion forms a scoop is located near the front edge of the airfoil.

11. An airfoil substantially as described with reference to Figures 1, 2, 4 and 5 or Figure 3 of the accompanying drawings.

12. An airfoil as claimed in any of the preceding claims including means for decreasing the air pressure on the upper surface of said airfoil comprising a chamber in said airfoil adjacent the outlet of the passage, an inwardly swinging rigid door hinged to the upper face of said airfoil and normally lying in the same plane with the upper face of said airfoil and closing the outlet of the passage and the said chamber, and means for variably moving said door into said chamber and exposing the outlet to allow air to be projected over said door upon opening of the passage by the said rear wall.

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1181991 COMPLETE SPECIFICATION

3 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

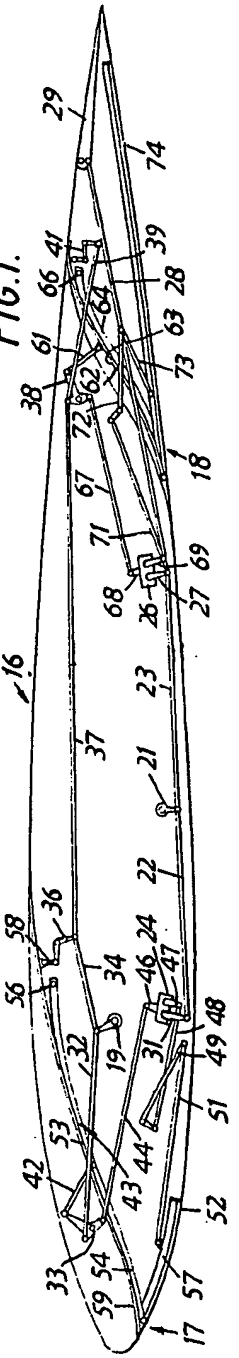

FIG.1.

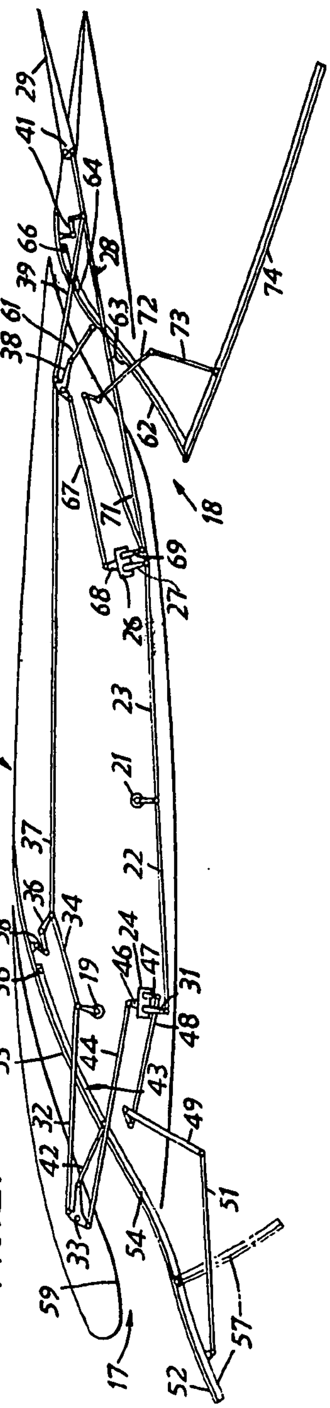

FIG.2.

1181991 COMPLETE SPECIFICATION

3 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 2

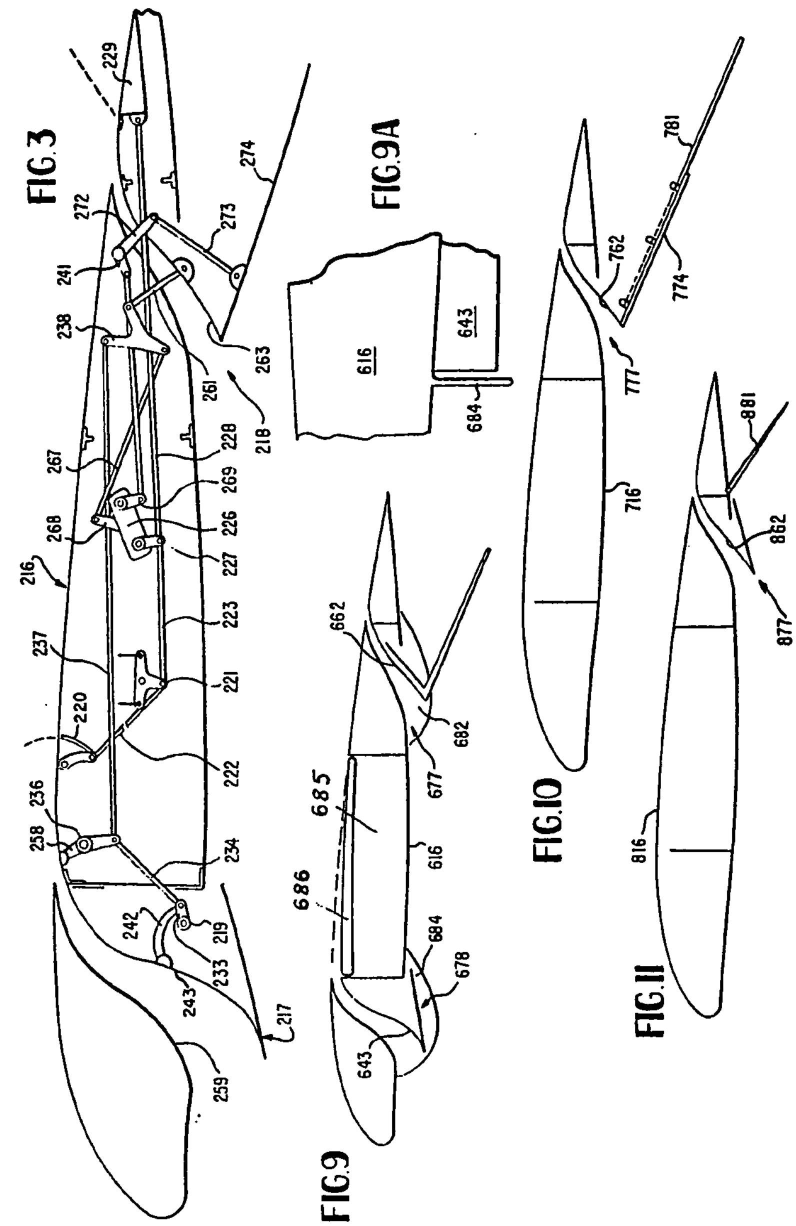

FIG.3

FIG.9A

FIG.9

FIG.10

FIG.11

FIG.5

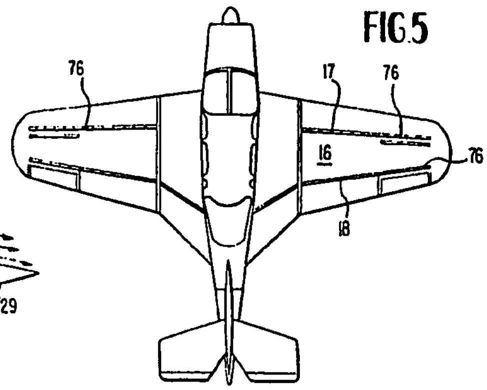

FIG.4

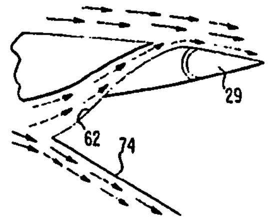

FIG.6

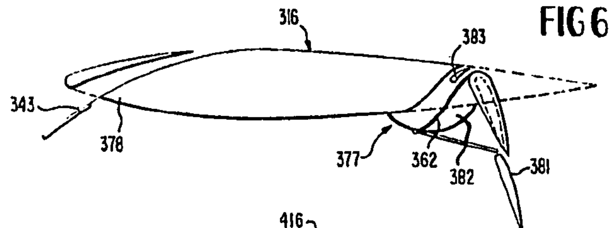

FIG.7

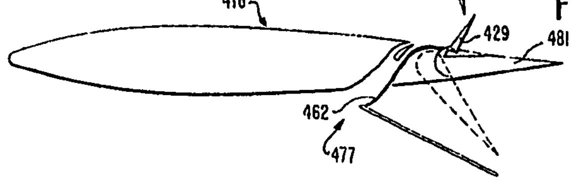

FIG.8

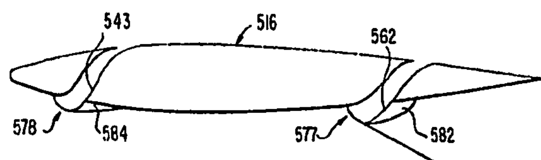

FIG.8A